CARDIOVASCULAR RISK ASSESSMENT of patients undergoing major vascular surgery is mandatory because perioperative and long-term morbidity and mortality are correlated with presence and severity of coronary artery disease.\(^1\) It is estimated that 36\% of patients undergoing abdominal aortic aneurysm surgery and 28\% of patients undergoing infrainguinal arterial bypass surgery have severe coronary artery disease; only 4\% of the patients had no signs of coronary artery disease.\(^2\) Recommendations for perioperative cardiovascular risk assessment of vascular patients are based on the guidelines of the American College of Cardiology and American Heart Association (ACC/AHA) for perioperative cardiovascular evaluation.\(^3\) The ACC/AHA guidelines provide a framework for considering cardiac risk based on the identification of potentially serious cardiac disorders, including coronary artery disease, congestive heart failure, valve disease, and arrhythmias. Moreover, with the help of these guidelines, disease severity, stability, and prior treatment can be defined, and comorbid conditions (eg, diabetes mellitus, peripheral vascular disease, renal dysfunction, and chronic pulmonary disease), functional capacity, age, and type of surgery can be considered to determine cardiac risk.\(^4\)

WHICH PATIENTS ARE MOST LIKELY TO BENEFIT FROM ADDITIONAL PREOPERATIVE NONINVASIVE TESTING?

The Clinical Utility of Cardiac Risk Indices

There have been several cardiac risk indices developed over the past 2 decades to simplify the assessment of cardiac risk in noncardiac surgery. Among these risk stratification tools, the Goldman cardiac risk index,\(^5\) the Detsky modified multifactorial risk index,\(^6\) and Eagle’s risk score\(^6\) have been the most often quoted risk indices used for perioperative cardiac risk assessment. With the help of these risk indices, patients can be stratified into low-, moderate-, and high-risk groups with respect to the likelihood of cardiac complications during the perioperative period. However, the performance of these indices has been questioned in subsequent studies. Gilbert et al\(^7\) prospectively compared the performance of 4 risk indices including the American Society of Anesthesiologists index, the Canadian Cardiovascular Society index, the Goldman index, and the modified Detsky index in 2,035 patients who underwent elective or urgent noncardiac surgery. The findings indicated that these indices performed better than chance for the prediction of perioperative cardiac complications, but no risk index was significantly superior. Lee et al\(^8\) also reviewed the predictive value of some of these risk indices including the Goldman and Detsky risk-assessment tools. Realizing the potential limitations of these previously developed risk indices, Lee et al derived and validated their own risk index in 4,315 patients who underwent elective noncardiac surgery including vascular surgery. Six risk factors including high-risk surgery (major vascular surgery), stroke, insulin-dependent diabetes mellitus, renal failure, congestive heart failure, and ischemic heart disease were identified as significant predictors of perioperative cardiac complications. In the presence of 0, 1, 2, and 3 or more risk factors, the incidence of major perioperative complications was 0.4\%, 0.9\%, 7\%, and 11\%, respectively. Although this study showed that with a limited number of risk factors patients could be classified as being at low, moderate, or high risk for cardiac complications, the role of noninvasive testing or cardioprotective medication use was not studied. Furthermore, only a small subgroup of patients of the entire study population (3.8\%) underwent major vascular surgery, and the positive predictive value of the index was low.

The Utility of the Guidelines for Considering Cardiac Risk in Noncardiac Surgery

The large number of studies describing cardiac risk factors for noncardiac surgery, the differences in the predictive performance of different risk indices, and the differences between studies describing the role and indication of noninvasive testing for perioperative cardiac risk assessment prompted the expert committee of the ACC/AHA to provide a framework for considering cardiac risk in noncardiac surgery in a variety of patients and operative situations. According to these guidelines, the first step in the evaluation of a patient scheduled to undergo major vascular surgery should determine the urgency of the planned procedure. Patients who need emergency vascular surgery should directly proceed to the operating room without the delay of additional cardiovascular risk evaluation. In contrast, a more thorough evaluation of the cardiac risk should be done in patients undergoing elective procedures. The initial step of
perioperative evaluation should include information from medical history, physical examination, basic laboratory testing, and electrocardiography to determine whether the cardiac risk for a patient is low, moderate, or high. Clinical predictors of increased perioperative cardiac risk according the ACC/AHA guidelines categorized as major, intermediate, and minor predictors. The major clinical predictors are active conditions (ie, unstable coronary syndromes, decompensated heart failure, significant arrhythmias, and severe valvular disease) that may mandate intensive medical management, which may result in delay or cancellation of surgery. Intermediate clinical predictors of increased perioperative cardiovascular risk are mild angina pectoris, previous myocardial infarction, compensated or prior heart failure, diabetes mellitus, and renal insufficiency. These risk factors are validated markers of enhanced cardiac risk, and patients with intermediate predictors are the most likely candidates for careful cardiac risk assessment including additional noninvasive cardiac testing. Patients with minor predictors of cardiac risk (advanced age, abnormal electrocardiography, rhythm other than sinus, reduced functional capacity, history of stroke, and hypertension) are considered to be at low risk for perioperative cardiac complications and may need no further cardiac risk evaluation.

Which Noninvasive Test To Choose for Perioperative Cardiac Risk Assessment?

Several noninvasive tests have been studied and described for the evaluation of perioperative cardiac risk. Exercise electrocardiography testing is the modality of choice in most ambulatory patients. The advantages of the test are that it provides an estimate of functional capacity and detects myocardial ischemia through changes in the electrocardiography and hemodynamic responses. The limitations are that patients at intermediate risk undergoing high-risk operations such as vascular surgery often have important abnormalities on their resting electrocardiography (eg, left bundle-branch block and left ventricular hypertrophy with strain pattern), which may preclude reliable ST-segment analyses. Moreover, vascular patients more often have limited exercise capacity because of noncardiac diseases such as peripheral artery disease, arthritis, and chronic pulmonary disease. Therefore, other noninvasive and nonexercise-dependent techniques such as pharmacologic myocardial perfusion scintigraphy or pharmacologic stress echocardiography should be considered.

Pharmacologic Myocardial Perfusion Scintigraphy

Diagnosis and assessment of the degree of coronary artery disease using myocardial perfusion scintigraphy are based on a differential blood flow distribution through left ventricular myocardium, perfused by normal or stenotic coronary vessels. A perfusion defect detected during testing may vary by size and reversibility. In patients with left anterior descending coronary artery stenosis, a perfusion defect is usually larger than a perfusion defect caused by a stenosis in the right coronary or circumflex arteries. Patients with multivessel coronary artery disease also have larger perfusion defects than patients with single-vessel disease. In addition to assessing the size and location of perfusion defects, reversibility of the thallium-201 perfusion defects can also be assessed by repeated imaging 3 to 4 hours later after obtaining the initial scans. The test results then are semi-quantitatively interpreted as having normal tracer uptake, moderately decreased uptake, or severely reduced uptake. In addition, the presence of pulmonary uptake of the tracer is associated with a reduced left ventricular function.

The Prognostic Value of Myocardial Perfusion Scintigraphy

Qualitative and quantitative assessment of a perfusion abnormality during pharmacologic myocardial perfusion scintigraphy may facilitate risk stratification of patients into low or high perioperative cardiac risk. Results from initial studies showed that patients who exhibited reversibility of the thallium-201 perfusion defects that normalized within 3 to 4 hours were at increased risk for perioperative cardiac risk. However, these results were later questioned by other investigators. These studies showed that the routine use of myocardial perfusion scintigraphy for preoperative screening of patients undergoing vascular surgery may not be justified. In agreement with these findings, the results of a recent meta-analysis of 23 studies showed that, despite the high sensitivity (83%) of the test, its specificity (49%) was too low for the prediction of cardiac death and myocardial infarction for patients undergoing major vascular surgery. There are several possible explanations for the findings of these studies: (1) the unrestricted use of the test in consecutive patients presenting for vascular surgery rather than in patients at intermediate risk for cardiac complications; (2) test results are directly available to treating physicians, thus influencing perioperative cardiac risk management; (3) repeat images 3 to 4 hours after thallium-201 injection may not allow sufficient time for thallium redistribution; and (4) thallium-201 uptake may be uniformly restricted in patients with severe and diffuse coronary artery disease. Nevertheless, semiquantitative analysis of the test results, taking into account the defect severity and extent, has been shown to increase the predictive value of the test. Dobutamine Stress Echocardiography

Dobutamine stress echocardiography has been shown to be a useful tool for preoperative cardiac risk stratification in patients undergoing noncardiac surgery, including major vascular surgery. Dobutamine is a synthetic catecholamine with β1-, β2-, and α1-receptor stimulating properties, and dobutamine has strong positive inotropic and modest chronotropic effect on the heart. During dobutamine infusion, heart rate and contractility increase, leading to increased myocardial oxygen demand. These effects result in myocardial ischemia and systolic contractile dysfunction in regions supplied by critically stenotic coronary arteries. During the stress test, dobutamine is intravenously administered with increasing infusion rates, starting at 10 μg/kg body weight per minute for 3 minutes, and the infusion rate is increased by 10 μg/kg per minute every 3 minutes to a maximum of 40 μg/kg per minute and continued for 6 minutes. For patients who do not achieve target heart rate at maximum dose, atropine in 0.25-mg increments up to 2.0 mg may be administered. Images are obtained at rest and during dobutamine-induced stress and are analyzed off-line.
according to the 17-segment model of the American Society of Echocardiography (Fig 1), and wall motion is scored in each segment on a 5-point scale.\(^{24,25}\) The test results are considered positive when wall motion in any segment deteriorates by 1 grade or more, with the exception of akinesia becoming dyskinesia during stress, which is considered to be a mechanical phenomenon.

**The Prognostic Value of Dobutamine Stress Echocardiography**

The prognostic value of dobutamine stress echocardiography for perioperative cardiac risk assessment in patients undergoing major vascular surgery has been extensively evaluated in recent reports\(^ {20,26-32}\) and was also summarized in a recent meta-analysis.\(^ {19}\) Kertai et al,\(^ {19}\) using a novel meta-analytic approach adjusting for reported variability in test performance between the individual studies, showed the clinical utility of dobutamine stress echocardiography in perioperative cardiac risk assessment. In total, 1,877 patients underwent dobutamine stress echocardiography in these reports, and the prognostic value of dobutamine stress echocardiography was studied for the prediction of cardiac death and nonfatal myocardial infarction. The overall sensitivity and specificity of the test derived from these studies were high (85% and 70%, respectively).\(^ {19}\) The direction and the magnitude of the predictive value of a positive dobutamine stress echocardiography result for the composite endpoint of cardiac death and myocardial infarction in these studies were also comparable. The overall estimate showed a significantly increased risk for perioperative cardiac death and myocardial infarction.

**WHICH TEST TO CHOOSE: DOBUTAMINE STRESS ECHOCARDIOGRAPHY VERSUS PERFUSION MYOCARDIAL SCINTIGRAPHY**

Numerous studies showed the prognostic value of dobutamine stress echocardiography and perfusion myocardial scintigraphy in vascular surgery candidates. However, these studies differ in sample size, study design, and pretest cardiac risk of the patients. Furthermore, there are also no studies comparing the 2 noninvasive tests in the same patient population. Data from recent meta-analyses may provide information about the comparability of the effectiveness of these tests which can enable clinicians to draw conclusions as to which test should be preferred for perioperative cardiac risk assessment. A meta-analysis by Mantha et al,\(^ {33}\) in which 20 studies were selected and the predictive estimates of 4 different noninvasive tests (dobutamine stress echocardiography, dipyridamole myocardial perfusion scintigraphy, radionuclide ventriculography, and ambulatory electrocardiography) were compared, showed that, with the exception of dobutamine stress echocardiography, each of the tests showed a bias for a better predictive value in the earlier studies. Although dobutamine stress echocardiography appeared to have the strongest predictive value for cardiac complications compared with dipyridamole myocardial perfusion scintigraphy and other tests, the available data analyzed were not sufficient to determine which test was optimal (Table 1).
In a similar meta-analysis, Shaw et al\textsuperscript{34} compared the predictive value of dipyridamole thallium-201 scintigraphy and dobutamine stress echocardiography for risk stratification before vascular surgery by analyzing data from 15 selected studies. The results showed that the prognostic value of both noninvasive stress tests had similar predictive accuracy, but the summed odds ratios for cardiac death and myocardial infarction were greater for dobutamine stress echocardiography than for myocardial perfusion scintigraphy (Table 1). Recently, Kertai et al\textsuperscript{35} compared the predictive value of dipyridamole stress echocardiography with dipyridamole stress echocardiography and dipyridamole thallium-201 scintigraphy in patients undergoing major vascular surgery. Clinical data of 2,204 consecutive vascular surgery patients were available from 3 separate studies; of these patients, 1,093 underwent dobutamine stress echocardiography.\textsuperscript{32} 394 patients had dipyridamole stress echocardiography,\textsuperscript{36} and 717 patients had dipyridamole thallium-201 scintigraphy\textsuperscript{37} before major vascular surgery. The results showed that there was no statistically significant difference in the predictive value of a positive test result for dobutamine stress echocardiography and dipyridamole stress echocardiography. However, a positive test result for dipyridamole thallium-201 scintigraphy had a significantly lower prognostic value compared with pharmacologic stress echocardiography (Table 1). Finally, the results of a recent meta-analysis indicated that dobutamine stress echocardiography had a significantly better predictive value for cardiac complications compared with myocardial perfusion scintigraphy\textsuperscript{38} but only a positive trend toward a better diagnostic performance as compared with the other tests (ambulatory electrocardiography, exercise electrocardiography, radionuclide ventriculography, and myocardial perfusion scintigraphy). In summary, the results of these meta-analyses indicate that dobutamine stress echocardiography has better predictive performance for the prediction of perioperative cardiac complications compared with myocardial perfusion scintigraphy and other noninvasive tests. Dobutamine stress echocardiography may also be the preferred test in the evaluation of women (frequent false-positive myocardial perfusion scintigraphy results caused by breast tissue) and if additional questions about valvular and left ventricular dysfunction exist. The additional benefit of the test is its safety. Results from a recent review of 6,595 stress tests indicated that the incidences of cardiac arrhythmias (8\%) and hypotension (3\%) were relatively low and comparable to the incidence of these side effects observed during myocardial perfusion scintigraphy test.\textsuperscript{38-40}

Nevertheless, dobutamine stress echocardiography should be avoided in the evaluation of patients with severe hypertension, hemodynamically significant ventricular arrhythmias, or in patients with poor acoustic window.
THE ROLE OF DOBUTAMINE STRESS ECHOCARDIOGRAPHY RESULTS IN CLINICAL ASSESSMENT AND MANAGEMENT OF VASCULAR SURGERY PATIENTS

Recognizing the complexity of the ACC/AHA guidelines algorithm for perioperative cardiac risk evaluation, disadvantages of using noninvasive cardiac testing in a large number of moderate- and high-risk patients, and the findings of several recent studies that perioperative β-blocker use associated with reduced complication rates in high-risk individuals prompted Boersma et al to study the relation between these factors and perioperative cardiac outcome in major vascular surgery candidates. A total of 1,351 consecutive patients scheduled for major vascular surgery were studied. Of these patients, 1,097 (81%) underwent dobutamine stress echocardiography, and 360 (27%) patients received β-blocker therapy. Forty-five patients (3.3%) had perioperative cardiac death or nonfatal myocardial infarction. Boersma et al also risk-stratified patients modifying the Lee cardiac risk index. Important clinical determinants of adverse outcome were age 70 years or older, current or prior angina pectoris, prior myocardial infarction, heart failure, cerebrovascular accident, renal insufficiency, and diabetes mellitus. The majority (83%) of patients had fewer than 3 clinical risk factors and were considered at low to moderate risk for cardiac complications. Among these subgroups, patients receiving β-blockers were at a lower risk for cardiac complications (0.8%) than those not receiving β-blockers (2.3%). These results indicated that the low cardiac event rate observed in low- and moderate-risk patients receiving β-blockers might not warrant additional noninvasive testing, and these patients could be scheduled for vascular surgery without further cardiac evaluation. However, dobutamine stress echocardiography was useful to further risk stratify patients at high risk (ie, patients with 3 or more risk factors correlated with higher risk of perioperative cardiac complications). High-risk patients without stress-induced myocardial ischemia during dobutamine stress echocardiography had a relatively low cardiac complication rate and could also be candidates for prompt surgery if protected by perioperative β-blocker use (no β-blocker use 5.8% vs β-blocker use 2%, cardiac event rate). High-risk patients with an abnormal test result were at considerable risk for cardiac complications despite β-blocker use. These results may suggest that in these patients further invasive cardiac evaluation could be necessary with subsequent myocardial revascularization. However, the recently presented results of the Coronary Artery Revascularization Prophylaxis (CARP) trial showed that coronary revascularization before vascular surgery in high-risk cardiac stable patients did not provide short-term survival benefit or better long-term event-free survival rate. The findings of the study indicated that patients undergoing coronary revascularization before vascular surgery had a 3.1% mortality rate within 30 days after vascular surgery compared with a 3.4% rate for those not having coronary revascularization (p = 0.87). Additionally, the rate of perioperative nonfatal myocardial infarction as detected by troponin elevations was also similar in coronary revascularization patients compared with patients not undergoing coronary revascularization (11.6% vs 14.3%, p = 0.37). Furthermore, the results of the trial also indicated that coronary revascularization before vascular surgery was associated with a delay or cancellation of the needed vascular operation. For these high-risk patients, a less-invasive surgical procedure (ie, endovascular procedure) and a combination of β-blockers and statins may offer additional benefit for the prevention of perioperative cardiac complications.

The Perioperative Utility of Statins in High-Risk Patients

Statins, apart from being potent low-density lipoprotein lowering agents, have also been shown to attenuate coronary artery plaque inflammation and influence plaque stability in addition to antithrombogenic-, antiproliferative-, and leukocyte-adhesion–inhibiting effects. These so-called pleiotropic properties of statins may stabilize unstable coronary artery plaques, thereby reducing myocardial ischemia and subsequent myocardial necrosis. These properties of statins have also been confirmed by several recently published studies. Poldermans et al showed in a case-control study that statin use was associated with a more than 4-fold reduced risk (adjusted odds ratio, 0.22, and 95% confidence interval, 0.10-0.47) of perioperative mortality. This result was consistent in subgroups of patients according to the type of surgery, cardiac risk factors, and cardioprotective medication use including aspirin and β-blockers. Durazzo et al also reported that vascular patients randomized to atorvastatin had a significantly reduced incidence of cardiovascular events within 6 months after vascular surgery compared with patients randomized to placebo (atorvastatin 8.3% vs placebo 26.0%). These observations were also confirmed in a large data set of 780,591 patients undergoing major noncardiac surgery. Statin use was associated with 28% (adjusted odds ratio, 0.62; 95% confidence interval, 0.58-0.67) relative risk reduction of in-hospital mortality compared with no statin use. Based on the results of the study, the authors calculated that on average 85 patients would need to be treated with statin therapy to prevent 1 perioperative death. When the number needed to treat was studied according to different cardiac risk categories, the results showed that 186 patients in the low–cardiac-risk group and only 30 patients in the high–cardiac-risk group would need to be treated to prevent perioperative death. Although these studies hold promising results for the reduction of perioperative cardiac events especially for high-risk patients with multiple cardiac risk factors or with significant coronary artery disease, future clinical trials are required to confirm the observed beneficial effect of perioperative statin use and provide valuable additional information about the effect of statin therapy in high-risk patients.

THE PROGNOSTIC VALUE OF DOBUTAMINE STRESS ECHOCARDIOGRAPHY BEYOND THE PERIOPERATIVE PERIOD

The Clinical Problem

A 5-year mortality rate for symptomatic patients with peripheral vascular disease is high (28%) and worse than the mortality rates for breast cancer (15%) and Hodgkin’s disease (18%). Peripheral arterial disease is a powerful indicator of systemic atherosclerosis, and patients with peripheral arterial disease have an increased risk of subsequent myocardial infarction and stroke and are 6 times more likely to die within 10
years than patients without peripheral arterial disease. Indeed, clinical studies also indicate that after vascular surgery patients still remain at increased risk for long-term cardiac complications. Krupski et al. showed a 15% incidence of cardiac death and myocardial infarction during a 2-year follow-up period in patients who underwent major vascular surgery. Similarly, the cardiovascular mortality (28%) was high of the 520 patients who underwent immediate abdominal aortic aneurysm repair and survived surgery in the UK Small Aneurysm Trial study. Therefore, to prevent future cardiovascular mortality of these patients, perioperative cardiac risk evaluation should also assess the risk of late cardiac complications.

**Prediction of Late Cardiac Events After Major Vascular Surgery**

To date, there are only a few large-scale studies in which the prognostic value of cardiac risk factors in combination with dobutamine stress echocardiography results were studied for the prediction of late cardiac events after major vascular surgery. Poldermans et al. reported long-term follow-up results of 316 patients who underwent major vascular surgery and were followed on average for 19 months. All patients underwent evaluation of cardiac risk factors and dobutamine stress echocardiography before vascular surgery. The results of this study showed that a history of myocardial infarction and extensive stress-induced myocardial ischemia during stress test were the strongest independent predictors of long-term cardiac events. When patients were risk stratified according to these 2 predictors, patients with no history of myocardial infarction and a negative test were at low risk for late cardiac events (Fig 2). Patients with either limited ischemia (1 or 2 ischemic segments) or a history of myocardial infarction were also at relatively low risk. Patients with limited ischemia and a history of infarction or with extensive ischemia (3 or more ischemic segments) without previous infarction were at moderately high long-term risk, whereas those with both extensive ischemia and a history of infarction were at extremely high risk (Fig 2). Although this study indicated that abnormal preoperative dobutamine stress echocardiography results combined with clinical data are of clinical use for defining the risk of late cardiac events in patients undergoing major vascular surgery, the role of cardioprotective medication use for the reduction of long-term cardiac events was not studied. Subsequently, Kertai et al. studied the long-term cardioprotective effect of β-blocker use in relation to cardiac risk factors and dobutamine stress echocardiography results in 1,286 vascular surgery patients.

<table>
<thead>
<tr>
<th>Stress-induced myocardial ischemia during DSE</th>
<th>Previous myocardial infarction</th>
<th>Event rate (%)</th>
<th>Hazard ratios (95% CI) for late cardiac events</th>
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<tr>
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<td>4/49 (8)</td>
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<tr>
<td>Extensive ischemia</td>
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<td>11/21 (52)</td>
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**Figure 2.** Long-term prognostic value of dobutamine stress echocardiography results in addition to a history of myocardial infarction in patients undergoing major vascular surgery. (Modified with permission.)
who survived surgery at least 30 days and were followed on average for 23 months. The results of this study showed that stress-induced myocardial ischemia during dobutamine stress echocardiography had additional prognostic value irrespective of the clinical risk profile of the patients. Long-term β-blocker use was associated with a significantly lower risk of cardiac event rate. However, the cardioprotective effect of β-blockers was more likely to depend on the presence of cardiac risk factors and stress-induced myocardial ischemia during dobutamine stress echocardiography testing. Based on these findings, prescribing long-term β-blocker use to patients with no cardiac risk factors may have only a marginal beneficial effect for the reduction of cardiac complications. Nevertheless, long-term beta-blocker use should be considered in these patients because of the unpredictable progression of coronary artery disease. Patients with 1 or 2 cardiac risks and with or without mild stress-induced myocardial ischemia should benefit from long-term β-blocker use. In contrast, β-blocker use was associated only with a modest reduction of long-term cardiac events in patients with multiple cardiac risk factors and extensive stress-induced myocardial ischemia. Because for these patients the risk of future cardiac events is very high, additional cardioprotective medication use such as long-term statin use or in case of symptomatic coronary artery disease coronary angiography and subsequent coronary revascularization could be considered.

**CONCLUSIONS**

Perioperative and long-term cardiac risk stratification using initial cardiac risk assessment and then selective noninvasive testing with dobutamine stress echocardiography may facilitate the perioperative and long-term management of patients under-
going major vascular surgery. As shown in Figure 3, the initial step of this approach should determine the risk of cardiac complications based on a set of clinical characteristics. The perioperative and long-term management should then depend on the presence and number of cardiac risk factors. Patients without cardiac risk factors are at low risk for perioperative and long-term cardiac complications and may not need to undergo additional noninvasive testing. In contrast, patients with 3 or more cardiac risk factors are at high risk for perioperative and long-term cardiac complications. Although the ACC/AHA guidelines suggest additional noninvasive testing in these high-risk patients and in case of an abnormal test result cardiac catheterization with subsequent coronary revascularization, the recently presented results of the CARP study indicate that coronary revascularization in high-risk cardiac stable patients would not improve perioperative and long-term outcome. Therefore, in these patients less-invasive surgical procedure (endovascular surgery) and additional cardioprotective measures should be considered such as a combination of β-blocker and statin use. The perioperative and long-term management, especially with regards to additional noninvasive testing of patients at moderate risk for cardiac complications, is at considerable debate. Ongoing studies like the PeriOperative Ischemic Evaluation trial and the Dutch Echocardiographic Risk Evaluation Applying Stress Echocardiography-2 trial (D Poldermans, personal communication, November 2004) will further evaluate the effectiveness of perioperative β-blocker use and the role of additional noninvasive testing with dobutamine stress echocardiography of moderate-risk patients undergoing noncardiac surgery including major vascular surgery. Until the results of these trials will become available, findings of the currently available studies may facilitate the decision to perform additional noninvasive testing for perioperative and long-term cardiac risk stratification and management of patients undergoing major vascular surgery.

REFERENCES
